

GEOCRES No. 30M5-140

DIST. 4 REGION

W.P. No.

CONT. No.

W. O. No. 82-26025

STR. SITE No.

HWY. No. Go-ALRr

LOCATION Oakville creek Bridge

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

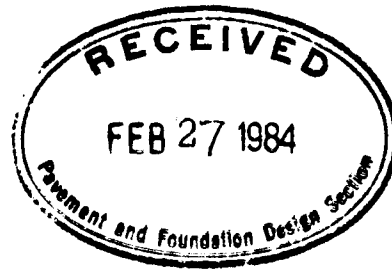
REMARKS:



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Ministry of
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OAKVILLE - HAMILTON SECTION

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WO 82-26025

DIST 4

HWY GO ALRT

SHELDON CREEK WEST STRUCTURE
FOUNDATION INVESTIGATION
AND DESIGN REPORT

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REPORT TO
MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS
DOWNSVIEW ONTARIO
GEOTECHNICAL INVESTIGATION
SHELDON CREEK WEST STRUCTURE
GO ALRT
BURLINGTON ONTARIO
(WO 82-26025)

February 24th, 1984

GEOCON

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APPENDIX I

Record of Boreholes

APPENDIX II

Figure 1	Plasticity Chart Fill - Silty Clay, some sand and gravel
Figure 2	Plasticity Chart Silty Clay, some sand and gravel
Figure 3	Grain Size Distribution Fill - Silty Clay, some sand and gravel
Figure 4	Grain Size Distribution Silty Clay, some sand and gravel
Drawing	W08226025A (at rear of report)

1.0 INTRODUCTION

Geocon has been retained by the GO ALRT programme to carry out a geotechnical investigation at the site of the proposed crossing of Sheldon Creek West. The above investigation has been carried out under the technical direction of Mr. K. G. Selby, Senior Foundation Engineer, Ministry of Transportation and Communications. The work was carried out in accordance with our proposal, dated January 10th, 1984.

The purpose of the investigation was to obtain subsurface information for use in design and construction of foundations for abutments and retaining walls required to support the proposed Sheldon Creek West structure and approach fills.

2.0 PROCEDURE AND EQUIPMENT

The field work for this investigation was carried out between January 12th and 18th, 1984. A Bombardier mounted B.O.A. power auger drill, equipped with hollow stem augers and BX rock coring equipment, was used to put down a total of 8 boreholes. The boreholes were identified as Boreholes 191 to 198 inclusive, and ranged from 3.8 to 5.3 metres in depth.

Samples were recovered within the overburden, in conjunction with the Standard Penetration Test, at intervals of about 1.5 metres. Uncased dynamic cone penetration tests were driven to refusal (greater than 100 blows per 0.3 metres) adjacent to each borehole location.

The underlying bedrock was cored in BX nominal size for depths ranging from 2.9 to 4.4. metres. The recovered core was examined to determine percent recovery, Rock Quality Designation (R.Q.D.) and bedrock condition.

Perforated plastic standpipes were installed within the bedrock stratum near the base of Boreholes 192, 194, 196, 197 and 198. Water levels were monitored from ground surface in the remaining uncased open boreholes. Water levels were observed throughout the period of the field programme with final water level readings taken on January 19th, 1984.

The recovered samples were transported to our Toronto Soil Mechanics Laboratory for detailed examination and testing. The samples remaining after testing will be stored until February, 1985 at which time they will be disposed of unless instructed otherwise.

3.0 SITE AND GEOLOGY

The proposed Sheldon Creek West structure is located within the City of Burlington about 0.7 Km west of Burloak Drive. The site is located to the south of The Queen Elizabeth Way along the proposed GO ALRT alignment which runs parallel to, and immediately north of, the existing C.N.R. tracks.

Sheldon Creek West flows in a general southerly direction crossing the GO ALRT alignment at about chainage station 19+670 metres. The boreholes of this investigation were put down within an area extending from about 12 metres north to 6 metres south of the centreline of the proposed GO ALRT line in the immediate vicinity of the creek.

The topography of the surrounding area is flat. Slopes of moderate steepness are associated with the creek. North of the C.N.R. lines the creek channel has been modified and straightened.

The site is situated about 4 Km north of Lake Ontario and is located to the south of the Iroquois Shoreline. The general area is described, by Chapman and Putnam, 1969, to consist of shale plains overlain by a thin layer of glacial till consisting to a large extent of material of local origin.

4.0 SUBSURFACE CONDITIONS

The site is generally covered with 0.3 to 1.3 metres of overburden overlying weathered shale and sound shale of the Queenston formation. At Borehole 192 about 2.3 metres of silty clay fill was encountered as the surficial stratum.

Details of the subsurface conditions are given in the Records of Boreholes, included in Appendix I. Borehole locations and subsurface conditions are also given on Drawing W0 8226025A included at the rear of this report.

The subsurface groundwater and soil conditions are described in detail in the following sections.

4.1 Fill - Silty Clay, some sand and gravel

A surficial stratum of silty clay, some sand and gravel fill was encountered, to a depth of 2.3 metres in Borehole 192. The cohesive stratum is described as being of a stiff consistency and is generally reddish brown in colour.

The results of grain size distribution analysis of a sample of the stratum are given on Figure 3 of Appendix II. The tests yielded results of 14 percent gravel, 31 percent sand, 41 percent silt and 14 percent clay.

The results of an Atterberg Limit Test, carried out on the minus 425 μ m portion of the sample, gave a liquid limit of 30.0 percent, plastic limit of 19.2 percent and natural water content of 12.9 percent. The results of the tests are shown on Figure 1 of Appendix II and indicate the soil to be a low plasticity clay or silty clay soil designated CL.

4.2 Silty Clay, some sand and organics

A surficial stratum of silty clay, some sand and organics was encountered in Boreholes 191 and 193 and ranged in thickness from 0.4 to 0.7 metres, respectively. The stratum was also encountered underlying the fill stratum in Borehole 192. The stratum was typically brown to black in colour and contained grass, roots and other organic material.

4.3 Silty Clay, some sand and gravel

Silty clay, some sand and gravel was encountered as the surficial stratum in Boreholes 194 to 198 inclusive. The generally cohesive stratum ranged from 0.5 to 1.3 metres in thickness.

Standard Penetration Tests, carried out within the stratum, indicate the soil is generally of a stiff consistency.

Grain size distribution analysis, carried out on two samples of the stratum yielded the following results.

<u>Borehole</u>	<u>Sample</u>	<u>Gravel</u>	<u>Sand</u>	<u>Silt</u>	<u>Clay</u>
194	1A	24	28	36	12
197	1	1	17	56	26

Grain size distribution varies throughout the stratum however in general the soil is described as a silty clay, some sand and gravel.

Atterberg Limit Tests carried out on the minus 425 μ m portion of select samples of the stratum yielded the following results:

4.0 SUBSURFACE CONDITIONS (continued)

4.3 Silty Clay, some sand and gravel (continued)

<u>Borehole</u>	<u>Sample</u>	<u>Liquid Limit</u>	<u>Plastic Limit</u>	<u>Plasticity Index</u>	<u>Natural Moisture Content</u>
194	1A	26.8	17.7	9.1	13.0
197	2A	31.5	18.4	13.1	14.8

The results of these tests are plotted on the Plasticity Chart on Figure 2 in Appendix II. The soil is described as silty clay to clay of low plasticity.

4.4 Weathered Shale

Weathered shale was encountered underlying the silty clay, some sand and gravel and silty clay some sand and organics in all boreholes. The stratum ranged in thickness from 1.3 to 3.4 metres in thickness. In the vicinity of the creek, and immediately to the west, the weathered shale was present at elevation 100.6 to 99.3 metres. Immediately to the east of the creek, in Boreholes 197 and 198, the weathered shale surface was encountered at elevations 103.6 and 103.0 metres respectively.

The weathered shale is generally reddish brown in colour. Greenish grey limestone beds are also occasionally present throughout the stratum. Rock core recoveries generally ranged from 55 to 100 percent however a recovery of 19 percent was reported during coring of the weathered shale in Borehole 198. Rock Quality Designation (R.Q.D.) values generally ranged from very poor to fair throughout the stratum.

4.0 SUBSURFACE CONDITIONS (continued)

4.5 Sound Shale Bedrock

Sound shale was encountered, underlying the weathered shale, at about elevation 97.0 to 97.5 metres, in the vicinity of the creek. Sound shale was present at elevation 98.5 and 99.3 metres in the two boreholes located to the west of the creek and at elevation 101.0 and 101.5 metres in the two boreholes located to the east of the creek.

The sound shale was reddish brown in colour with occasional greenish grey shale and limestone beds. Occasional silty clay layers were also present in the stratum. The bedrock was generally sound and intact.

Bedrock recovery generally ranged from 86 to 100 percent. Recovery of 55 percent was reported in Borehole 193 however this value reflects lost core from within the overlying weathered shale which was cored in the same run.

R.Q.D. values for the sound shale generally ranged from 55 to 100 percent indicating fair to excellent bedrock conditions. A poor R.Q.D. value was reported in Borehole 193 and reflects lost core in the weathered shale as described above.

4.6 Groundwater Conditions

Groundwater levels determined during the investigation generally ranged from about elevation 99.5 to 100.5 metres and in some instances may not represent the stabilized groundwater level due to the impermeable nature of the shale bedrock.

An accurate groundwater level was not obtained in Borehole 198 and could be expected to be higher than the above given values. Groundwater levels could be expected to vary seasonally.

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5.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

It is understood that a single span, closed abutment rigid bridge structure is to be constructed to carry the Sheldon Creek West GO ALRT line crossing. The rail line embankment is to be supported on the approach to the bridge structure abutments with 13 metre long retaining walls of about 8 metres height. The proposed structure is to be constructed immediately north of the existing CNR line. The layout of the proposed structure is shown on Drawing W08226025A.

5.1 Proposed Bridge Structure

Conventional spread footing may be used to support the proposed bridge structure. Surficial silty clay and silty clay, some sand and organics, should be stripped in the area of the proposed foundations.

For a final creek bed at about elevation 99.1 metres it is recommended that the weathered shale stratum be excavated and the spread foundation be placed on the underlying sound shale bedrock at elevation 97.0 metres.

The spread foundation of the proposed structure should be designed using a factored bearing capacity at the U.L.S. of 1500 kPa. The bearing capacity at S.L.S. Type II will not govern the design.

5.2 Proposed Retaining Walls

The proposed retaining walls may also be supported on conventional spread foundations. Surficial fill, silty clay and silty clay some sand and organics, should be excavated at the location of the proposed footings. The spread foundations may be founded within the weathered shale stratum or on the underlying sound shale bedrock.

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5.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (continued)

5.2 Proposed Retaining Walls (continued)

Spread foundations, for the retaining walls situated to the west of the creek, should be founded at or below elevation 99.0 metres if these foundations are located within the weathered shale stratum. Similarly spread foundations should be founded at or below elevation 97.5 metres if located within the sound shale bedrock.

To the east of the creek the spread foundations, if located within the weathered shale, should be founded at or below elevation 99.5 at the east bridge abutment and may be stepped below a straight line rising to a maximum elevation of 103 metres at the east end of the proposed 13 metre long retaining walls. Similarly spread foundations if located on the sound shale bedrock, should be founded at or below elevation 97.0 metres at the east abutment and may be stepped below a straight line rising to a maximum elevation of 101.0 metres at the east end of the proposed 13 metre long retaining walls.

The spread foundations on the weathered shale should be designed using a factored bearing capacity at U.L.S. of 1000 kPa. Spread foundations on the sound shale bedrock may be designed using a factored bearing capacity at the U.L.S. of 1500 kPa. The bearing capacity at S.L.S. Type II will not govern the design.

For inclined resultant loads the factored bearing capacity at U.L.S. should be reduced as specified in the Ontario Highway Bridge Design Code (O.H.B.D.C.) 1982, Section 6.7.3.3.5/.

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5.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (continued)

5.3 General Design and Construction Recommendations

1. A minimum of 1.2 metres of cover should be provided above the base of all foundations for frost protection purposes.
2. A concrete working slab, of 100 mm minimum thickness, should be placed on the surface of the weathered shale and/or sound shale within 12 hours of excavation to the founding level.
3. The Sheldon Creek West stream channel should be diverted from the foundation excavation throughout the construction period.
4. The bridge abutments, retaining walls and associated earthworks should be designed to resist stream flow scour and should be stable under flood conditions.
5. The silty clay, trace sand and gravel fill identified on the west side of Sheldon Creek West, as well as the silty clay, some sand and organics, in this area, should be excavated prior to placement of approach fills. In addition all topsoil should be removed within the limits of the approach fills.
6. Backfill to the structure should be constructed of free draining engineered granular fill (M.T.C. Granular B) in accordance with M.T.C. Standard Special Provision 121 October, 1983. Suitable positive drainage should be provided to prevent the build up of excess hydrostatic pressure behind the retaining wall.
7. Computation of earth pressures should be in accordance with Section 6.6.1.2/ of the O.H.B.D.C. If M.T.C. Granular "A" backfill is to be used the following properties

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5.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (continued)

5.3 General Design and Construction Recommendations (continued)

7. (continued)

may be assumed for design: $\gamma = 22 \text{ kN/m}^3$, $\phi = 35^\circ$. For M.T.C. Granular "B" a wide range of values for γ and ϕ exist. Unless the source of the material is known and soil tests are carried out prediction of the above values may be subject to error. In this case it will be necessary to compute earth pressures in accordance with Section 6.6.1.2.2/. It should be noted for earth pressure coefficients that the at rest condition applies since the foundations are considered to be non yielding.

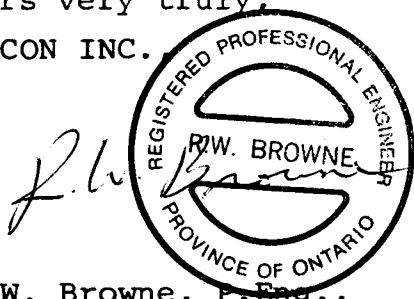
8. Lateral forces on the retaining walls and abutments may be resisted by keying the footing into bedrock, a minimum of 0.5 metres and designing the footing using a coefficient of friction of 0.47 ($\tan 25^\circ$) between the footing and bedrock. Alternatively lateral forces may be resisted by the installation of dowels a minimum of 1.5 metres into bedrock.
9. The extent to which passive resistance is developed at the base of the retaining walls should be established when details of the final slope grading is established.
10. No stability problems are anticipated for embankments with slopes of 2H : 1V or flatter. If steeper slopes are required we would be pleased to recommend suitable slope angles and required erosion control procedures.

6.0 CLOSURE

Field work for this investigation was carried out under the supervision of our Mr. R. F. Mokracki, P.Eng. This letter has been written by Mr. R. W. Browne, P.Eng. with technical input from Mr. H. L. MacPhie, P.Eng.

We trust this letter contains sufficient detail for your purpose. Please contact us should you require elaboration on any matter.

Yours very truly,
GEOCON INC.

A circular stamp for a Registered Professional Engineer in the Province of Ontario. The text around the circle reads "REGISTERED PROFESSIONAL ENGINEER" at the top and "PROVINCE OF ONTARIO" at the bottom. In the center, the name "R.W. BROWNE" is printed. A handwritten signature, which appears to be "R.W. Browne", is written across the stamp.

R. W. Browne, P.Eng.,
Project Engineer.

RWB/pw
T10757/42110

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APPENDIX I

Record of Boreholes

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EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



RECORD OF BOREHOLE No 191

METRIC

W P 82-26025 LOCATION 4 804 792.9N ; 284 059.6E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 12 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
100.2	Ground Level													
0.0	Silty Clay, some sand and organics						100	AUGERED						
99.8	Brown to Black		1A	SS										
0.4	Shale Bedrock Weathered Reddish Brown	1B	SS	200/	0.25m			260/D.10m						
98.5							99							RQD
1.7			2	RC BX	75%									70%
	Shale Bedrock Sound Reddish Brown													
			3	RC BX	100%									100%
							98							
							97							
96.4														
3.8	END OF BOREHOLE													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 192

METRIC

W P 82-26025 LOCATION 4 804 798.0N ; 284 050.1E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 13 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
101.7	Ground Level																
0.0	Fill - Silty Clay, some sand and gravel trace organics Stiff Reddish Brown		1	SS	17												
			2	SS	10												
99.4	Silty Clay, some sand and organics Br. to Blk		3A	SS	138/	0.25m											
99.3			3B	SS	130/	0.10m											
2.4	Shale Bedrock Weathered Reddish Brown		4	SS	130/	0.10m											
			5	RC BX	87%												
98.2	Shale Bedrock Sound Reddish Brown		6	RC BX	100%												
96.4																	
5.3	END OF BOREHOLE																

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 193

METRIC

W P 82-26025 LOCATION 4 804 804.7N ; 284 068.8E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 13 CHECKED BY RLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
100.0	Ground Level													
0.0	Silty Clay, some sand and organics													
	Brown to Black													
99.3			1	SS	119/0									
0.7	Shale Bedrock Weathered		2	RC BX	100%									
	Reddish Brown													
			3	RC BX	55%									
97.5														
2.5	Shale Bedrock Sound													
	Reddish Brown		4	RC BX	95%									
95.4														
4.6	END OF BOREHOLE													



RECORD OF BOREHOLE No 194

METRIC

W P 82-26025 LOCATION 4 804 812.8N ; 284 052.7E ORIGINATED BY RFM
DIST 3 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 16 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
100.6	Ground Level																
0.0	Silty Clay, some sand and gravel Stiff Reddish Brown		1a	SS	12												24 28 36 12
100.0			1b		106/C.15m		100										
0.6	Shale Bedrock Weathered Reddish Brown		2	SS	190/C.25m												RQD
			3	RC BX	70%		99										55%
							98										
97.5																	
3.1	Shale Bedrock Sound Reddish Brown		4	RC BX	100%		97										85%
96.3																	
4.3	END OF BOREHOLE																

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 195

METRIC

W P 82-26025 LOCATION 4 804 813.5N ; 284 070.6E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 17 CHECKED BY RLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
100.2	Ground Level										
0.0	Silty Clay, some sand and gravel										
99.9	Reddish Brown										
0.3			1	SS	170/	0.2m		100/0.03m			
			2	SS	150/	0.1m					
	Shale Bedrock Weathered										
	Reddish Brown		3	RC BX	72%						
			4	RC BX	100%						
97.0											
3.2	Shale Bedrock Sound										
	Reddish Brown										
96.1											
4.1	END OF BOREHOLE										

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 196

METRIC

W P 82-26025 LOCATION 4 804 818.8N ; 284 065.7E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 17 CHECKED BY RLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
100.9	Ground Level																
0.0	Silty Clay, some sand and gravel Reddish Brown																
100.4																	
0.5			1	SS	210	0.18m											
			2	SS	207	0.25m											
	Shale Bedrock Weathered Reddish Brown																
			3	RC BX	95%												
			4	RC BX	81%												
			5	RC BX	100%												
97.0																	
3.9	Shale Bedrock Sound Reddish Brown		6	RC BX	90%												
96.0																	
4.9	END OF BOREHOLE																

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 197

METRIC

W P 82-26025 LOCATION 4 804 827.3N ; 284 081.0E ORIGINATED BY RFM
 DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
 DATUM Geodetic DATE 1984 01 18 CHECKED BY ReB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
104.9	Ground Level													
0.0	Silty Clay, some sand and gravel Stiff Reddish Brown		1	SS	11									
103.6			2A	SS	20									
1.3			2B		163/	0.3m								
	Shale Bedrock Weathered Reddish Brown		3	SS	215/	0.25m								
			4	SS	200/	0.1m								
			5	RC BX	86%									
101.5														
3.4	Shale Bedrock Sound Reddish Brown													
100.6														
4.3	END OF BOREHOLE													

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 198

METRIC

W P 82-26025 LOCATION 4 804 831.7N ; 284 067.5E ORIGINATED BY RFM
DIST 4 HWY GO ALRT BOREHOLE TYPE Standard Auger, Cone Test, BX Core COMPILED BY AEL
DATUM Geodetic DATE 1984 01 18 CHECKED BY RB

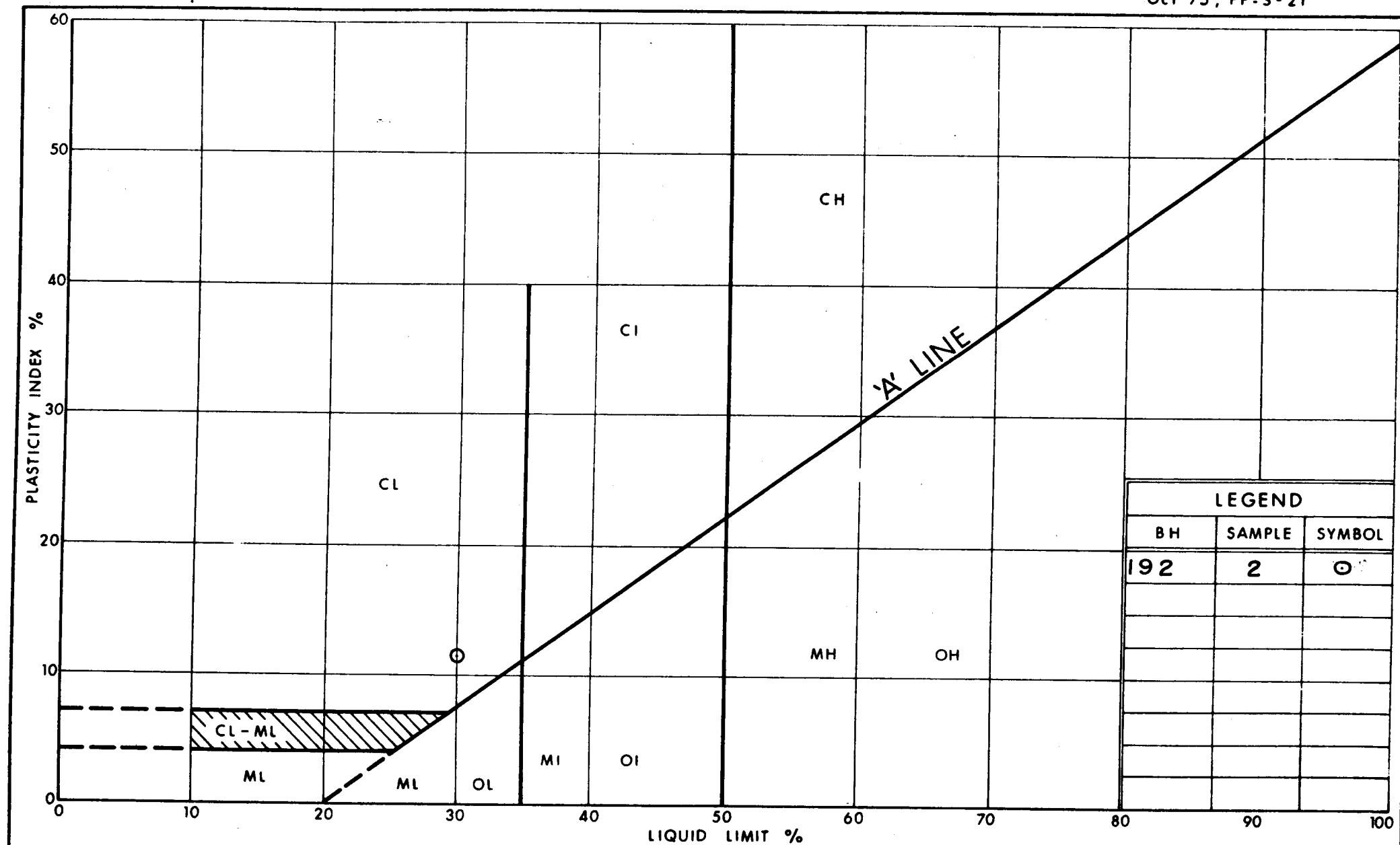
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
103.8 0.0	Ground Level Silty Clay, some sand and gravel Reddish Brown					No water level recorded 0.15m	103						WATER CONTENT (%)				RQD
103.0 0.8	Shale Bedrock Weathered Reddish Brown		1	SS	235												
			2	SS	220												
			3	BX RC	19%												
101.0 2.8	Shale Bedrock Sound Reddish Brown		4	BX RC	100%		101										100%
100.0 3.8	END OF BOREHOLE						100										

+³, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

APPENDIX II

- Figure 1 Plasticity Chart
 Fill - Silty Clay, some sand and gravel
- Figure 2 Plasticity Chart
 Silty Clay, some sand and gravel
- Figure 3 Grain Size Distribution
 Fill - Silty Clay, some sand and gravel
- Figure 4 Grain Size Distribution
 Silty Clay, some sand and gravel
- Drawing WO8226025A
 (at rear of report)



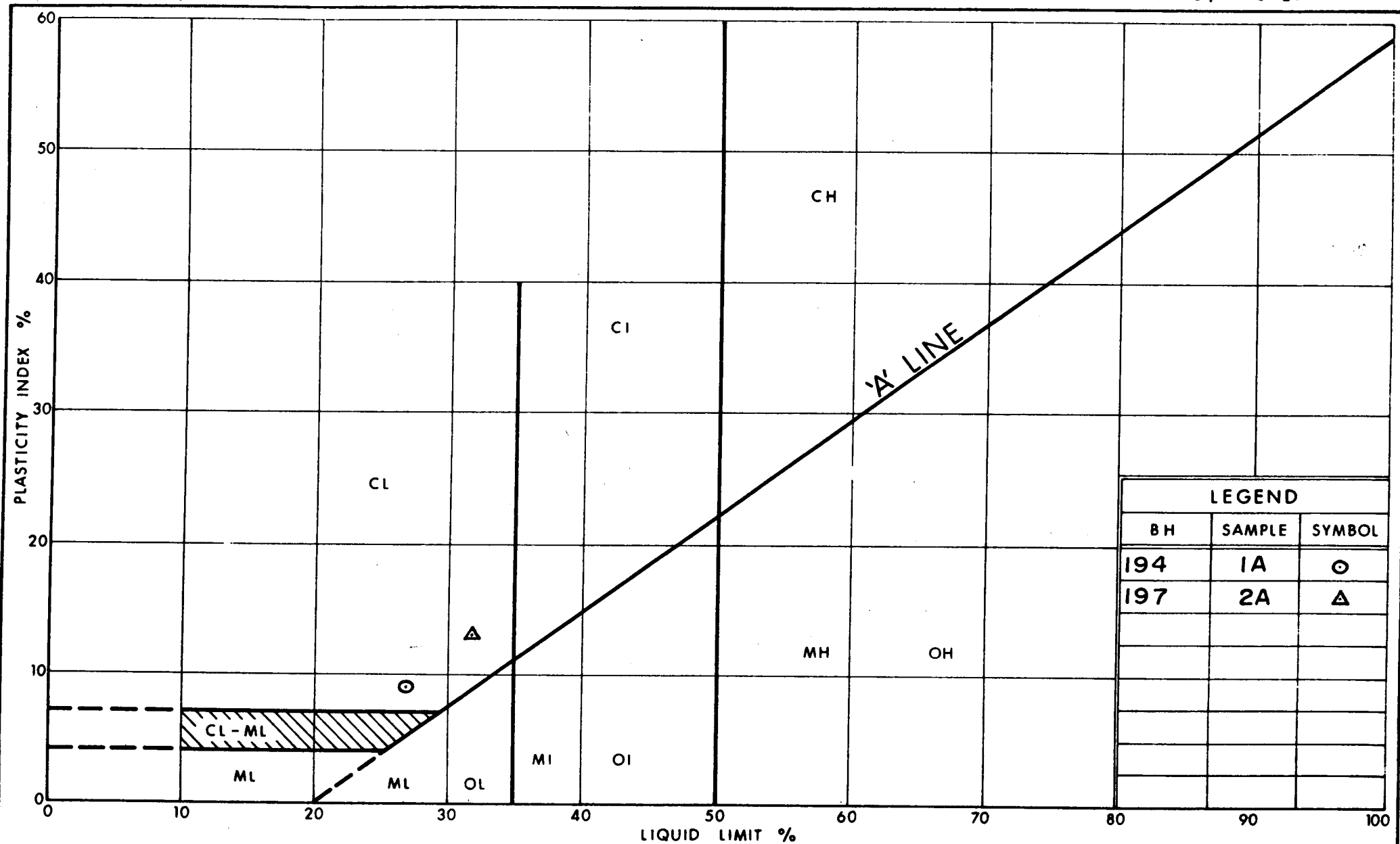
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PLASTICITY CHART

FILL SILTY CLAY TRACE SAND AND GRAVEL

FIG No 1

W P



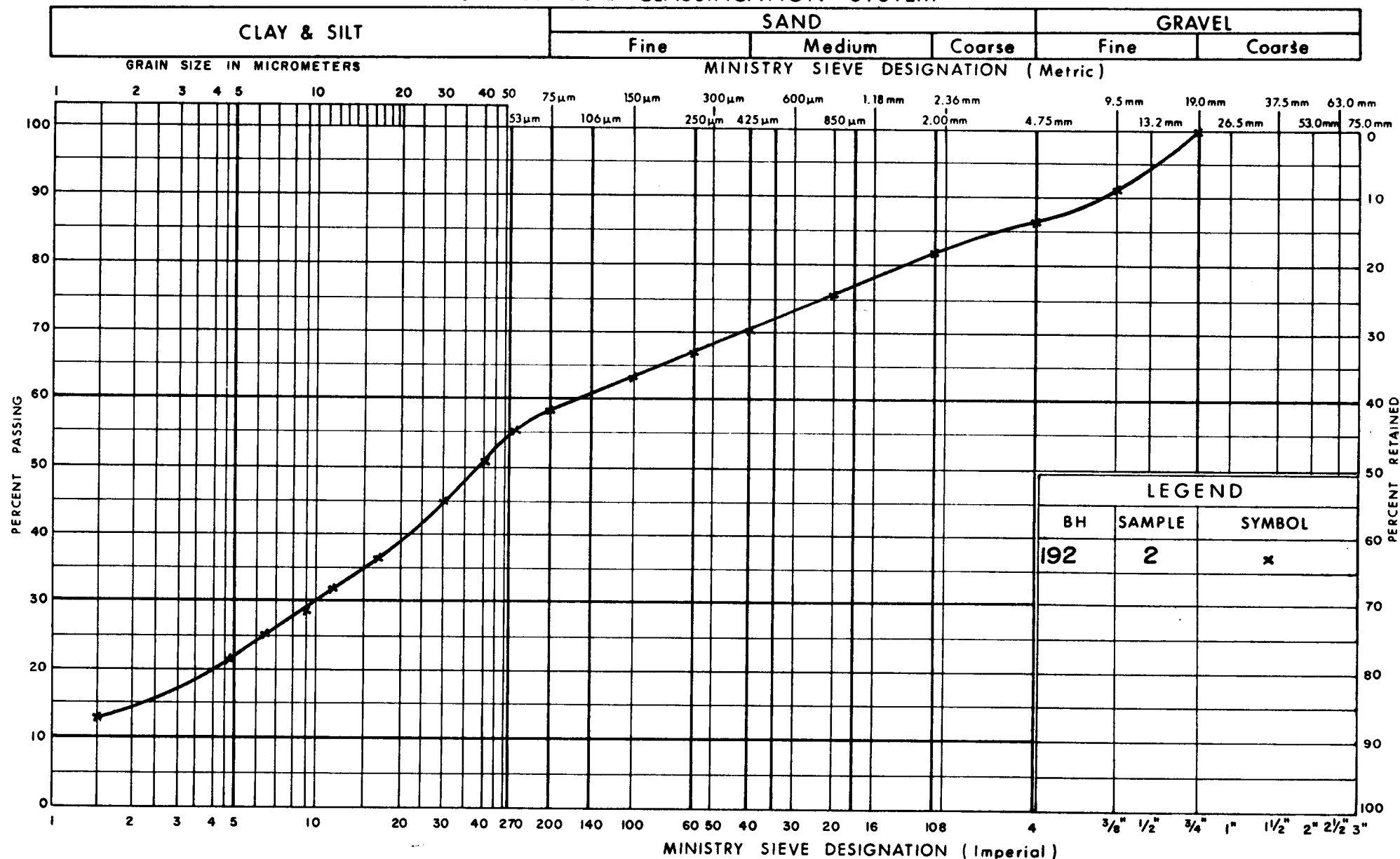
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PLASTICITY CHART SILTY CLAY SOME SAND & GRAVEL

FIG No 2

W P

UNIFIED SOIL CLASSIFICATION SYSTEM



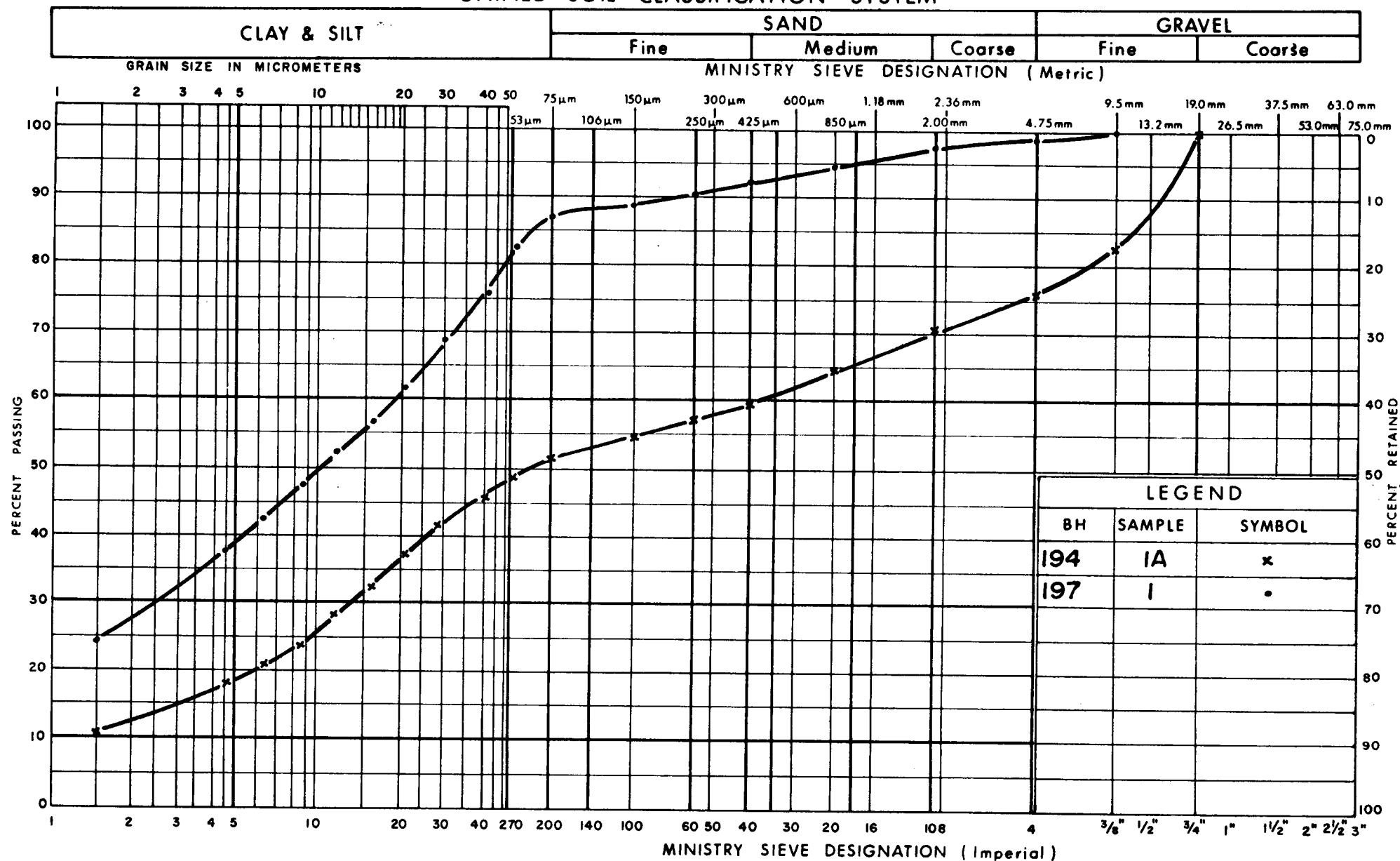
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GRAIN SIZE DISTRIBUTION
FILL SILTY CLAY SOME SAND AND GRAVEL

FIG No 3

W P

UNIFIED SOIL CLASSIFICATION SYSTEM

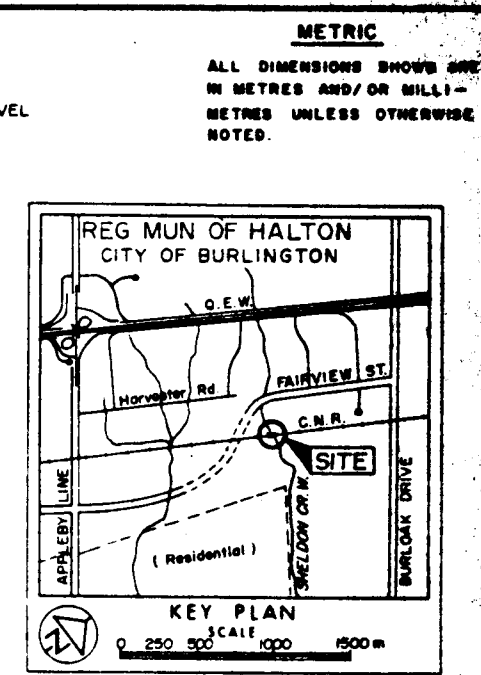
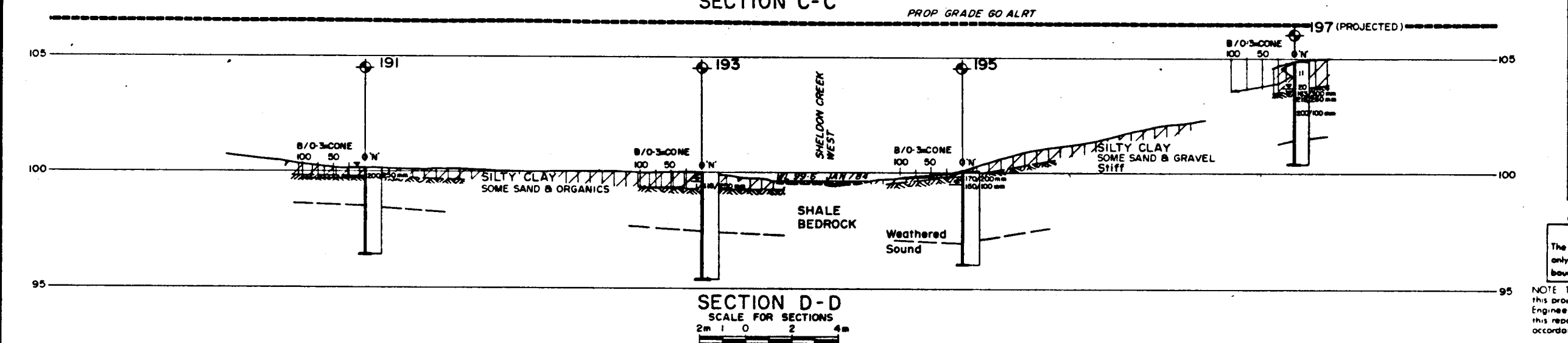
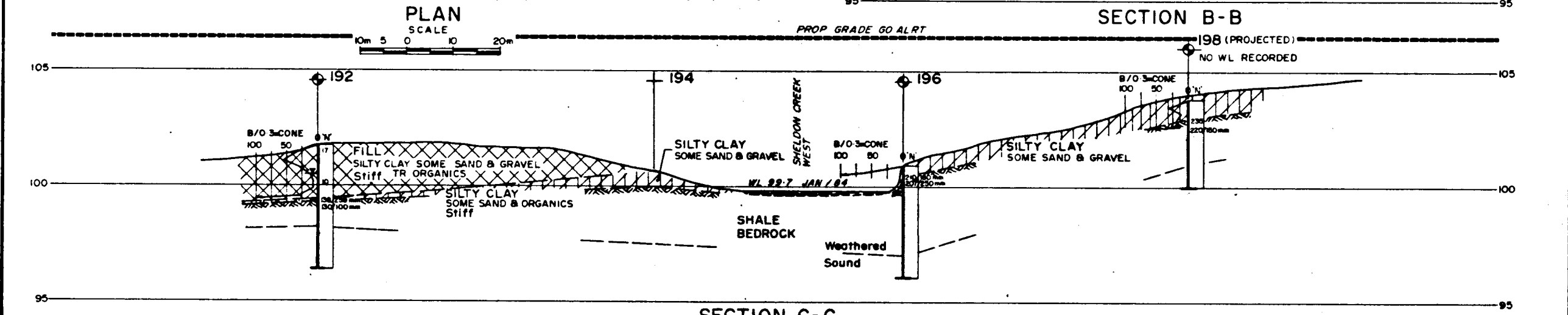
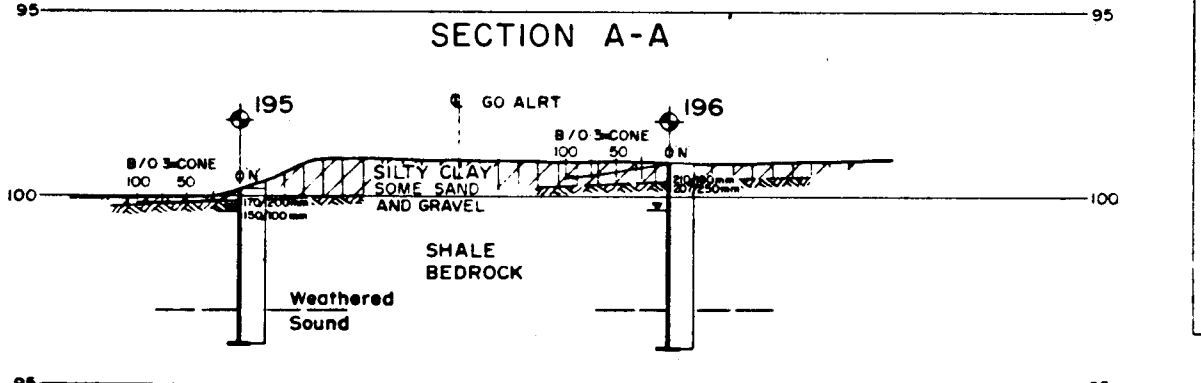
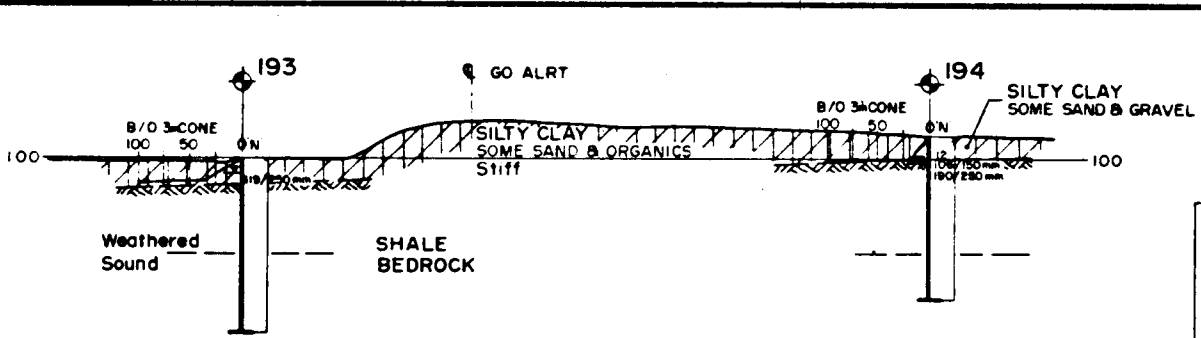
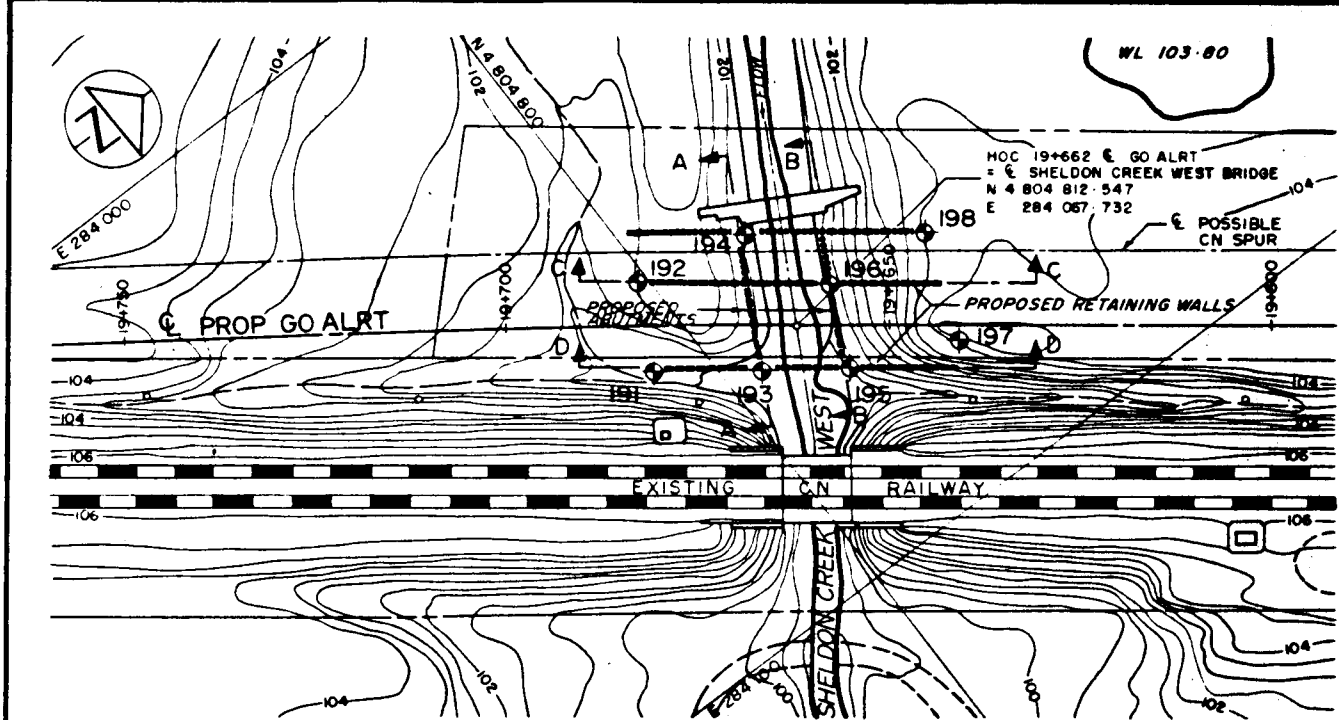


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GRAIN SIZE DISTRIBUTION
SILTY CLAY SOME SAND AND GRAVEL

FIG No 4

W P



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/0.3m (3rd Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 84 01

No	ELEVATION	CO ORDINATES NORTH	EAST
191	100.2	4 804 792.9	284 086.8
192	101.7	4 804 798.0	284 050.1
193	100.0	4 804 804.7	284 088.8
194	100.6	4 804 812.8	284 082.7
195	100.2	4 804 813.5	284 070.6
196	100.9	4 804 818.8	284 085.7
197	104.9	4 804 827.3	284 081.0
198	103.8	4 804 831.7	284 067.5

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

GO-ALRT REF PD2-300

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: A.E. LOCKHART 84 02 17 CHK'D BY: DESIGNED BY: APPROVED BY: SCALE: FULL SIZE ONLY AS SHOWN		GEOCON INC. 	HALTON REGION SHELDON CREEK WEST BRIDGE BORE HOLE LOCATIONS & SOIL STRATA STA 19+662	CONTRACT NO DWG NO REV SHEET
P-015 PARKER CONSULTANTS REV 0 GO ALRT - HALTON REGION SHELDON CREEK WEST BRIDGE GENERAL ARRANGEMENT STA 19+662 DATED: 83 12 02				PROJECT MANAGER				



Geocon

GEOTECHNICAL CONSULTANTS

February 14th, 1984

GEOCON INC
3210 AMERICAN DRIVE, MISSISSAUGA
ONTARIO, CANADA L4V 1B3
TELEPHONE (416) 673-1664
TELEX 06-968801

Ministry of Transportation and Communications,
Pavement and Foundation Design Section,
Room 315, Central Building,
1201 Wilson Avenue,
Downsview, Ontario.

Attention: Mr. K.G. Selby, P.Eng.
Senior Foundation Engineer.

Re: GEOTECHNICAL INVESTIGATION,
PROPOSED SHELDON CREEK WEST BRIDGE,
BURLINGTON, ONTARIO.
GO ALRT PROJECT WO 82-26025.

Dear Sirs:

We are pleased to present a summary of our factual information and our geotechnical design recommendations for the above investigation. Our foundation investigation and design report will be submitted in the near future.

It is understood that a single span, closed abutment rigid bridge structure is to be constructed to carry the Sheldon Creek West GO ALRT line crossing. The rail line embankment is to be supported on the approach to the bridge structure abutments with 13 metre long retaining walls of about 8 metres height. The proposed structure is to be constructed immediately north of the existing CNR line. The layout of the proposed structure and the location of the 8 boreholes put down is shown on the attached figure.

1.0 SUBSURFACE CONDITIONS

In the immediate vicinity of the creek ground surface is underlain by silty clay or silty clay with organics typically ranging

1.0 SUBSURFACE CONDITIONS (continued)

in thickness from 0.3 to 0.7 metres. Weathered shale bedrock underlies the silty clay stratum and was typically penetrated to depths ranging from 1.8 to 3.4 metres. Sound shale was encountered at elevation 97.0 to 97.5 metres in the area of the proposed bridge abutments.

On the east side of Sheldon Creek West stiff silty clay, some sand and gravel was encountered as the surficial stratum and was penetrated to depths of 1.3 and 0.8 metres. Weathered shale bedrock underlies the silty clay at elevations 103.0 and 103.6 metres. The weathered shale is about 2 metres in thickness. Sound shale bedrock was encountered at elevations 101.5 and 101.0 metres.

On the west side of Sheldon Creek west a thin surficial stratum of silty clay, some sand and organics was encountered along the alignment of the proposed south retaining wall. Along the alignment of the north retaining wall a 2.3 metre thickness of stiff silty clay, trace sand and gravel fill was encountered. The fill is underlain by a thin layer of silty clay, some sand and organics which is underlain by weathered shale bedrock, of about 1.5 to 1.1 metres in thickness. Sound bedrock was encountered at about elevation 98.2 metres and was cored to about elevation 96.4 metres.

2.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

2.1 Proposed Bridge Structure

Conventional spread footing may be used to support the proposed bridge structure. Surficial silty clay and silty clay, some

2.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (continued)

2.1 Proposed Bridge Structure (continued)

sand and organics, should be stripped in the area of the proposed foundations.

For a final creek bed at about elevation 99.1 metres it is recommended that the weathered shale stratum be excavated and the spread foundation be placed on the underlying shale bedrock at elevation 97.0 metres.

The spread foundation of the proposed structure should be designed using a factored bearing capacity at the U.L.S. of 1500 kPa. The bearing capacity at S.L.S. Type II will not govern the design.

2.2 Proposed Retaining Walls

The proposed retaining walls may also be supported on conventional spread foundations. Surficial fill, silty clay and silty clay some sand and organics, should be excavated at the location of the proposed footings. The spread foundations may be founded within the weathered shale stratum or on the underlying shale bedrock.

Spread foundations, for the retaining walls situated to the west of the creek, should be founded at or below elevation 99.0 metres if these foundations are located within the weathered shale stratum. Similarly spread foundations should be founded at or below elevation 97.5 metres if located within the shale bedrock.

To the east of the creek the spread foundations, if located within the weathered shale, should be founded at or below

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2.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (cont'd)

2.2 Proposed Retaining Walls (cont'd)

elevation 99.5 at the east bridge abutment and may be stepped below a straight line rising to a maximum elevation of 103 metres at the east end of the proposed 13 metre long retaining walls. Similarly spread foundations if located on the shale bedrock, should be founded at or below elevation 97.0 metres at the east abutment and may be stepped below a straight line rising to a maximum elevation of 101.0 metres at the east end of the proposed 13 metres long retaining walls.

The spread foundations on the weathered shale should be designed using a factored bearing capacity at U.L.S. of 1000 kPa. Spread foundations on the shale bedrock may be designed using a factored bearing capacity at the U.L.S. of 1500 kPa. The bearing capacity at S.L.S. Type II will not govern the design.

For inclined resultant loads the factored bearing capacity at U.L.S. should be reduced as specified in the Ontario Highway Bridge Design Code (O.H.B.D.C.) 1982, Section 6.7.3.3.5/

2.3 General Design and Construction Recommendations

1. A minimum of 1.2 metres of cover should be provided above the base of all foundations for frost protection purposes.
2. A concrete working slab, of 100 mm minimum thickness, should be placed on the surface of the weathered shale and/or shale bedrock within 12 hours of excavation to the founding level.

2.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (cont'd)

2.3 General Design and Construction Recommendations (cont'd)

3. The Sheldon Creek West stream channel should be diverted from the foundation excavation throughout the construction period.
4. The bridge abutments, retaining walls and associated earthworks should be designed to resist stream flow scour and should be stable under flood conditions.
5. The silty clay, trace sand and gravel fill identified on the west side of Sheldon Creek West, as well as the silty clay, some sand and organics, in this area, should be excavated prior to placement of approach fills. In addition all topsoil should be removed within the limits of the approach fills.
6. Backfill to the structure should be constructed of free draining engineered granular fill (M.T.C. Granular B) in accordance with M.T.C. Standard Special Provision 121 October, 1983. Suitable positive drainage should be provided to prevent the build up of excess hydrostatic pressure behind the retaining wall.
7. Computation of earth pressures should be in accordance with Section 6.6.1.2/ of the O.H.B.D.C. If M.T.C. Granular "A" backfill is to be used the following properties may be assumed for design: $\gamma = 22 \text{ kN/m}^3$, $\phi = 35^\circ$. For M.T.C. Granular "B" a wide range of values for γ and ϕ exist. Unless the source of the material is known and soil tests are carried out prediction of the above values may be subject to error. In

2.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS (cont'd)

2.3 General Design and Construction Recommendations (cont'd)

7. (cont'd)

this case it will be necessary to compute earth pressures in accordance with Section 6.6.1.2.2/. It should be noted for earth pressure coefficients that the at rest condition applies since the foundations are considered to be non yielding.

8. Lateral forces on the retaining walls and abutments may be resisted by keying the footing into bedrock, a minimum of 0.5 metres and designing the footing using a coefficient of friction of 0.47 ($\tan 25^\circ$) between the footing and bedrock. Alternatively lateral forces may be resisted by the installation of dowels a minimum of 1.5 metres into bedrock.
9. The extent to which passive resistance is developed at the base of the retaining walls should be established when details of the final slope grading is established.
10. No stability problems are anticipated for embankments with slopes of 2H : 1V or flatter. If steeper slopes are required we would be pleased to recommend suitable slope angles and required erosion control procedures.

Ministry of Transportation and Communications
February 14th, 1984
Page 7.

3.0 CLOSURE

This letter has been written by Mr. R.W. Browne, P.Eng. with technical input from Mr. H.L. MacPhie, P.Eng.

We trust this letter contains sufficient detail for your purpose. Please contact us should you require elaboration on any matter.

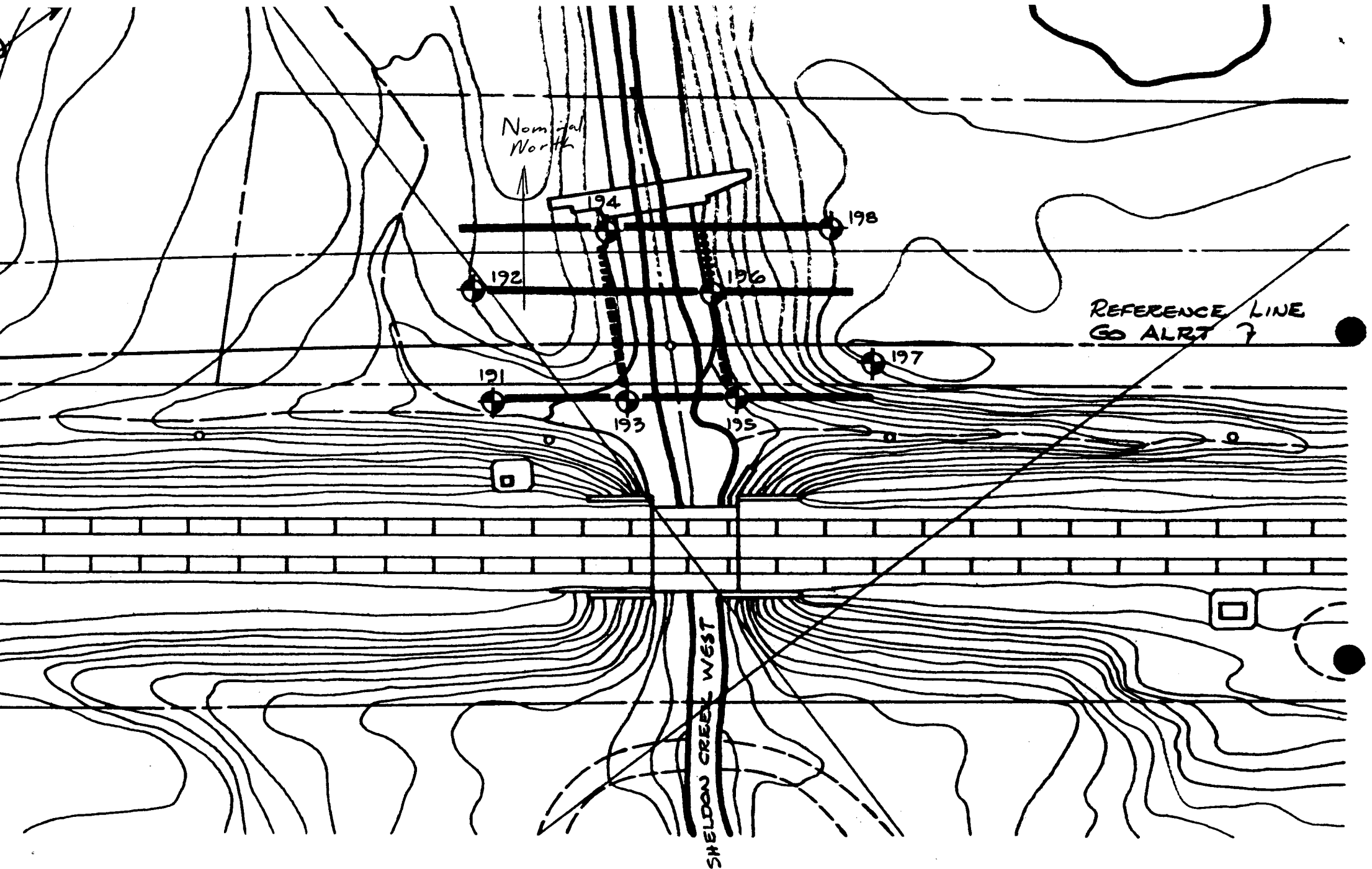
Yours very truly,
GEOCON INC.



R.W. Browne, P.Eng.
Project Engineer

RWB:bg
T10757/42110

GEOCON



SHELDON CREEK WEST BRIDGE

Scale 1:500

Ref DWG. No. P-015 Rev. 0

memorandum



To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
5000 Yonge Street, Willowdale

Date: 83 04 08

Attention: Mr. M.D. Bendayan

From: Pavement & Foundation Design Section
Room 315, Central Building
Downsview

Re: Feasibility Foundation Investigations
W.O. 82-26025-R
GO-ALRT Structures
Oakville Project, West Extension
(Walker's Line, Burlington to
Trafalgar Road, Oakville)
District 4 Hamilton

This section has reviewed the feasibility of the proposed crossings required for the above-noted project. Our comments, which are based on anticipated site conditions (derived from previous investigations in the general area and site visits) follow.

GENERAL SITE DESCRIPTION

The sites are located in the physiographic region of the Iroquois Plain, a strip of land between the existing shoreline of Lake Ontario and the previous shoreline of Lake Iroquois.

Generally, (i.e. at most locations) the overburden consists of a thin (< 3 Metre) layer of low plasticity silty clay till (with sand and gravel). The consistency of this material is estimated to range from firm to hard.

...2

However, at the major creeks, the thickness of the overburden may increase and the deposits may become more varied. These conditions are a result of

- deep stream valleys being eroded into the underlying bedrock when the level of Lake Ontario was lower than at present, and
- the subsequent deposition of materials when Lake Ontario rose to its present level.

The bedrock in the area is shale. At some sites, it may be overlain by transitional zones grading from silty clay with shaly layers to weathered shale.

The elevations of the groundwater at the site are influenced by the bedrock contours and therefore vary across the study area. Outside of the creek valleys, it is estimated that the groundwater elevation will be in the middle of the overburden layer. Within the creek valleys, the groundwater elevations will gradually decrease to the water level in the creeks.

FEASIBILITY OF PROPOSALS

No serious foundation-related problems are anticipated for any of the proposals.

It is anticipated that

- foundations for subways, culverts and bridges may be constructed by following usual MTC practices.
- these structures may be supported on spread footings founded on the hard glacial till or the shale bedrock.
- if required, abutments may be perched within approach fills, in which case foundation support can be provided by steel H-piles equipped with reinforced tips and driven to bedrock, or alternatively spread footings on compacted granular fill.
- estimated recommended design values for these alternatives for the purposes of the O.H.B.D.C. follow.

<u>Alternative</u>	<u>Factored Capacity at ULS</u>	<u>Capacity at SLS Type II</u>
Spread footings on shale bedrock	1500 kPa	will not govern design
Spread footings on hard glacial till	1000 kPa	670 kPa
Perched abutment footing on compacted granular fill	900 kPa	340 kPa
Steel 310 HP 110 H-piles driven to bedrock	1600 kN per pile	1150 kN per pile

(Note that for steel H-piles of different sizes, the recommended design values may be assumed to be directly proportional with their cross-sectional areas.)

- differential settlements are not expected to exceed 25 mm.
- dewatering is not expected to be a major problem due to the generally impervious nature of the soil.

If there are any questions, please contact this office.

D. H. Dundas
D. H. Dundas, P. Eng.
Project Foundations
Engineer

DHD:bg



OAKVILLE-HAMILTON SECTION



Ontario

Ministry of
Transportation and
Communications



OAKVILLE-HAMILTON SECTION
ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

W O 82-26025 DIST 4

HWY 60-ALRT STR SITE

Oakville Project-West Extension
60-ALRT Shoreacres Creek Bridge
C.N.R. Spur Shoreacres Creek Bridge

DISTRIBUTION

K. Pask (5)
G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore
R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)
Files

GEOCREs

DATE

FOUNDATION INVESTIGATION REPORT
FOR
W O 82-26025, Site
District 4, Hamilton
GO-ALRT, West Extension, Oakville Project
GO-ALRT Shoreacres Creek Bridge
C.N.R. Spur Shoreacres Creek Bridge

1.0 INTRODUCTION

This report summarizes the results of the foundation investigation for the proposed bridge structures.

The field work was carried out in the period of February 7 to 14, 1984 and consisted of ten boreholes drilled with a CME 75 trackmounted drilling machine supplied and operated by Atcost Soil Drilling Inc.

Elevations referred to in this report are related to a Benchmark (elevation 103.543 m), located 26.2 m left of Station 22+209.500 on the GO-ALRT centreline.

2.0 SITE DESCRIPTION

The proposed bridge structures are located between approximately Station 22+223 and 22+248 on GO-ALRT at Shoreacres Creek, about 20 m north of the C.N.R. tracks and about 700 m east of Walkers Line in the City of Burlington. This area is part of the physiographic region known as the Iroquois Plain which extends between the present shoreline of Lake Ontario and the previous shoreline of Lake Iroquois. The characteristic surficial deposits in the general area consist of

2.0 SITE DESCRIPTION (Continued)

cohesive glacial till and/or residual (weathered) bedrock of variable and generally shallow thickness, overlying reddish-brown shale bedrock of the Queenston Formation.

Shoreacres Creek has cut a shallow valley through this area with a relatively flat western slope and a steeper (about 1 vertical to 3.5 horizontal) eastern slope. Shale bedrock is exposed in the banks and bottom of the creek.

Land use in the area is light commercial.

3.0 SUBSURFACE CONDITIONS

3.1 General

The Record of Borehole Sheets show the subsurface conditions at the borehole locations. The locations and elevations of the boreholes and stratigraphical profiles based on the borehole data are shown on the Borehole Locations and Soil Strata Drawing which together with the Record of Borehole Sheets are appended to this report.

Bedrock was encountered at the ground surface at the location of each borehole.

3.2 Bedrock

The bedrock is of the Queenston Formation and consists of reddish-brown thinly, horizontally or nearly horizontally, bedded fine grained calcareous sandy shale interbedded with thin bands of

3.0 SUBSURFACE CONDITIONS (Continued)

grey shale and, occasionally, very thinly laminated fine grained grey calcareous sandston. The grey bands are on the average 300 to 800 mm apart and of the order of 25 to 75 mm in thickness. The shale can be easily scratched by finger nail and is readily broken by hammer.

The upper part of the shale is weathered to depths ranging from about 800 to 1800 mm and severely weathered to depths of the order of 400 to 1100 mm. The original structure of the severely weathered shale is difficult to recognize and has been reduced to silty clay of low to medium plasticity mixed with shale fragments, some sand and gravel.

Sound shale was encountered at depths of about 800 to 1800 mm at corresponding elevations ranging from 102.1 to 99.6 and core drilled in all boreholes. Overall core recoveries ranged from 84 to 100% with a median value of 98% indicating that the bedrock is generally sound. R.Q.D.'s ranged from 0 to 73% with a median value of 62% indicating the rock to be of very poor to good and, on the average, of fair quality.

With the exception of Boreholes 261, 262 and 265, total or partial loss of return water was noted during rock coring. These losses occurred generally between about elevations 99 and 96 but it was not possible to determine any distinct pattern between elevations and the amount of loss.

3.3 Groundwater

Piezometers were installed in Boreholes 262, 264, 267, 268 and 269 and the ground levels in the piezometers as well as in other (open) boreholes were monitored throughout the period of the field work. Final readings were taken on february 22, 1984 and

3.0 SUBSURFACE CONDITIONS (Continued)

these readings are shown on the borehole logs and on the stratigraphic profiles. On the basis of these observations it is concluded that the groundwater level at the site, at the time of the investigation, was at about elevation 101, i.e. close to the water level in Shoreacres Creek at the crossing.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

The proposed bridges are understood to be single, 14 m span, rigid frame structures carrying GO-ALRT and an adjacent C.N.R. Spurline over Shoreacres Creek which will be re-channelled at this location. The elevation of the finished creek bed at the crossing will be at about 100. The top of rail for GO-ALRT is planned at elevation 105.370 and the bottom of rail for the spurline will be at elevation 104.940.

4.2 General Foundation Design Considerations

The structure and its retaining walls may be founded on footings in the shale bedrock. Footings should be placed below the depth of frost influence, i.e. not higher than about 1200 mm below final grade. A further limiting factor in the determination of founding elevations may be the possibility of scour at the abutment footings. The latter consideration is subject to the results of a hydrological study which is outside the scope of this report. However, the creek bottom which is at about elevation 100.7 near Boreholes 263 and 264 and at about elevation 100.9 near Boreholes 269 and 270, appears to consist of shale.

4.0 DISCUSSION AND RECOMMENDATIONS (Continued)

Sound bedrock commences at about elevation 99.85 at Boreholes 263 and 264 and at about elevation 100.25 at Boreholes 269 and 270. It would therefore appear that scour in this area will not be significant.

Based on the current conceptual design, it would appear that the footings for the abutments would be placed at or below about elevation 98.6. The founding elevations for the retaining walls are, in terms of frost protection requirements, influenced by the final grading in the area of the approach embankments. On the basis of the present topography of the general area, it is considered that the founding elevation of the footings for the western retaining walls would probably be of the order of 98.6 over the full length of the walls. At the eastern approach the current topography suggests that footing levels could rise gradually from about elevation 98 to 101 along the length of the wall in an eastern direction.

4.3 Foundation Recommendations

The founding conditions at the locations of the abutments may be judged on the basis of the results of Boreholes 262, 265 and 268 for the east abutment and of Boreholes 263, 266 and 269 for the west abutment. In Boreholes 263, 266 and 269, sound shale bedrock occurs below elevations 99.8 to 100.2. In Boreholes 262, 265 and 268 sound shale bedrock was encountered below elevations 99.6 to 100.2. It is therefore concluded that the probable founding level for the abutments (at or below elevation 98.6) is well within sound bedrock.

The founding conditions at the locations of the western retaining walls may be judged on the basis of the results of Boreholes 263, 264, 269 and 270. The lowest elevation where sound bedrock commenced in any of these four boreholes was elevation 99.8.

4.0 DISCUSSION AND RECOMMENDATIONS (Continued)

It is therefore probable that the anticipated founding level of elevation 98.6 will be wholly in sound rock.

In the area of the eastern retaining walls (Boreholes 261, 262, 267 and 268) the lowest elevation of sound bedrock appears to be at about elevation 99.5 at Boreholes 262 rising to 100.2 at Borehole 268 and at 102.9 and 101.7 at Boreholes 261 and 267 respectively. Consequently the anticipated founding levels between elevations 99.5 and 100 would seem to be generally in sound rock.

It is recommended that all footings be founded in sound shale bedrock at a factored bearing capacity at ultimate limit states of 1500 kPa. As far as the bearing capacity at serviceability limit states is concerned, the design of the foundations is not governed by settlement as the loading required to cause detrimental settlement of the structure will be much larger than 1500 kPa.

Total and differential settlements in the structure are considered to be negligible.

4.4 Lateral Pressures

Backfill behind abutments and retaining walls should consist of granular material, in accordance with Standard Special Provision No. 121 dated October, 1983, and earth pressures acting on the walls should be computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. It should be assumed that the foundation is non-yielding, so that "at rest" (K_0) conditions apply. For Granular 'A' backfill, $\phi = 35^\circ$ and $\gamma = 22.0 \text{ kN/m}^3$ may be used. If Granular 'B' backfill is used, a rather wide range of values for ϕ and γ could apply and unless the exact properties are known, the earth pressure should be computed in accordance with Section 6.6.1.2.2 of the O.H.B.D.C.

4.0 DISCUSSION AND RECOMMENDATIONS (Continued)

4.5 Stability

The lateral resistance of the foundation to sliding may be computed using a friction coefficient of 0.35 between the footing and the bedrock. If required, further lateral resistance may be obtained from keying into the rock or by the provision of dowels.

4.6 Construction

The present channel of Shoreacres Creek can readily be diverted as necessary in order to allow the main structure to be built without impeding the flow. At the time of this investigation, groundwater was present in the shale at about elevation 101. As there is no reason to assume that the groundwater regime in the area is subject to significant changes, it can be anticipated that excavations will intersect groundwater. However, this is not expected to cause unusual construction problems.

It should be noted however that the sound shale, when allowed to become wet upon exposure, will quickly begin to disintegrate to the extent that the bearing capacity can be seriously affected or destroyed. It is therefore recommended that excavations be dewatered as required. Upon exposure of the founding level, all soft or loose material should be removed and the final bearing level should be protected from deterioration by a cover of 150 mm of mass concrete.

On the basis of the core recovered from the boreholes it is our opinion that the rock can be removed with normal excavating equipment, but it is probably necessary to use ripper teeth. Blasting is unlikely to be required and, in any event, not recommended in view of the proximity of the CNR tracks.

4.0 DISCUSSION AND RECOMMENDATIONS (Continued)

4.7 Embankments

The maximum height of the approach embankments appears to be of the order of 6 m in the vicinity of the structures. The surficial weathered rock in the area is generally clayey and locally soft and compressible and/or organic to depths of the order of 600 mm. It is recommended that such materials be stripped to depths below which the natural soil or weathered rock has at least a very stiff consistency, i.e. an in-situ shear strength of not less than 100 kPa. This requirement is important and its object is to remove weak horizontal planes which, at shallow depths, can create potential slip surfaces. The natural soil or weathered rock, when at least of very stiff consistency is suitable for the support of embankments with normal side slopes of 1 vertical to 2 horizontal.

5.0 MISCELLANEOUS

The field work for this investigation was carried out under the direction of Mr. G. Niculae, P.Eng. The report was prepared under the guidance of Mr. A. Prior, P.Eng.

Submitted by

L.J. RAK ENGINEERING LTD.



A. Prior, P.Eng.

AP/mk

Enc.

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 261

METRIC

W 0 82-26025 LOCATION Co-ords N 4 802 789.0 E 282 530.0 ORIGINATED BY GN
 DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
 DATUM Geodetic DATE 84 02 10 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
103.24	Ground Surface		1	SS	15		103				
	weathered sound		2	SS	50	125mm	102				
	Bedrock Shale Queenston Formation		3	RC BXL	REC 97% RQD 20%		101				
			4	RC BXL	REC 97% RQD 53%		100				
98.85							99				
4.39	End of Borehole						98				
	* organic to 300 mm severely weathered to ± 600 mm										

RECORD OF BOREHOLE No 262

METRIC

W 0 82-26025 LOCATION Co-ords N 4 802 780.5 E 282 522.0 ORIGINATED BY GN
 DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
 DATUM Geodetic DATE 84 02 10 CHECKED BY AP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
101.14	Ground Surface									
0.00	Bedrock Shale Queenston Formation weathered sound		1	SS	12					
			2	SS	50/150mm					
			3	RC BXL	REC 96% RQD 47%					
			4	RC BXL	REC 100% RQD 61%					
			5	RC BXL	REC 100% RQD 66%					
95.34										
5.80	End of Borehole * frozen severely weathered to ± 600 mm									



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RECORD OF BOREHOLE No 263

METRIC

W 0 82-26025 LOCATION Co-ords N 4 802 769.0 E 282 512.0 ORIGINATED BY GN
DIST 4 HWY G0-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 09 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
100.94	Ground Surface											
0.00	Bedrock Shale Queenston Formation * weathered sound		1	SS	25							
			2	SS	50/	75mm						
			3	RC BXL	REC 90% RQD 50%							
			4	RC BXL	REC 93% RQD 78%							
			5	RC BXL	REC 100% RQD 77%							
95.14												
5.80	End of Borehole * frozen severely weathered to ± 600 mm											

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 264

METRIC

W O 82-26025 LOCATION Co-ords N 4 802 760.0 E 282 508.0 ORIGINATED BY GN
DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 07 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
100.98	Ground Surface										
0.00	Bedrock Shale Queenston Formation		1	SS	53						
			2	SS	50						
	weathered sound		3	RC BXL	REC 97% RQD 73%						
			4	RC BXL	REC 98% RQD 71%						
96.64	End of Borehole										
4.34	* frozen severely weathered to ± 600 mm										

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 265

METRIC

W 0 82-26025 LOCATION Co-ords N 4 802 784.5 E 282 510.5 ORIGINATED BY GN
DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 13 CHECKED BY AP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
101.65	Ground Surface												
0.00	Bedrock Shale Queenston Formation	*	1	SS	12								
			2	SS	12								
	weathered sound		3	SS	50/	100mm							
			4	RC BXL	REC 91% RQD 0%								
			5	RC BXL	REC 98% RQD 76%								
			6	RC BXL	REC 98% RQD 78%								
95.66	End of Borehole												
5.99	* frozen severely weathered to ± 1000 mm												

RECORD OF BOREHOLE No 266

METRIC

W O 82-26025 LOCATION Co-ords N 4 802 771.5 E 282 501.0 ORIGINATED BY GN
 DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
 DATUM Geodetic DATE 84 02 08 & 09 CHECKED BY AP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
100.95	Ground Surface		1	SS	2								
0.00	weathered sound		2	SS	50%	75mm							
	Bedrock Shale Queenston Formation		3	RC BXL	84% 20%								
			4	RC BXL	REC 98% RQD 32%								
			5	RC BXL	REC 100% RQD 75%								
			6	RC BXL	REC 100% RQD 76%								
95.24													
5.75	End of Borehole												
	* severely weathered to ± 600 mm												



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RECORD OF BOREHOLE No 267

METRIC

W O 82-26025 LOCATION Co-ords N 4 802 797.0 E 282 510.5 ORIGINATED BY GN
DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 14 CHECKED BY AP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
103.10	Ground Surface									
0.00	Bedrock * Shale Queenston Formation		1	SS	16					
	weathered sound		2	SS	44					
			3	RC BXL	REC 100% RQD 47%					
			4	RC BXL	REC 100% RQD 63%					
98.63	End of Borehole									
4.47	* organic to ± 400 mm severely weathered to ± 600 mm									

+³, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 268

METRIC

W O 82-26025 LOCATION Co-ords N 4 802 786.5 E 282 502.5 ORIGINATED BY GN
DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 14 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
101.66	Ground Surface		1	SS	11						
0.00	Bedrock Shale Queenston Formation	*	2	SS	81						
	weathered sound		3	RC BXL	REC 90% RQD 11%						
			4	RC BXL	88% 60%						
			5	RC BXL	REC 97% RQD 57%						
			6	RC BXL	REC 100% RQD 71%						
95.51	End of Borehole										
6.15	* organic to 150 mm severely weathered to ± 1100 mm										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 269

METRIC

W 0 82-26025 LOCATION Co-ords 4 802 775.0 E 282 493.5 ORIGINATED BY GN
DIST 4 HWY G0-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 08 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
101.13	Ground Surface	*	1	SS	4		101						
	weathered sound		2	SS	50	100mm	100						
	Bedrock Shale Queenston Formation		3	RC BXL	REC 92% RQD 39%		99						
			4	RC BXL	REC 100% RQD 78%		98						
			5	RC BXL	REC 100% RQD 77%		96						
95.18	End of Borehole						95						
5.95	* severely weathered to ± 600 mm												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 270

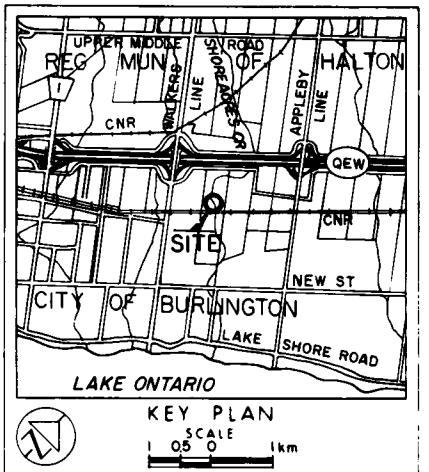
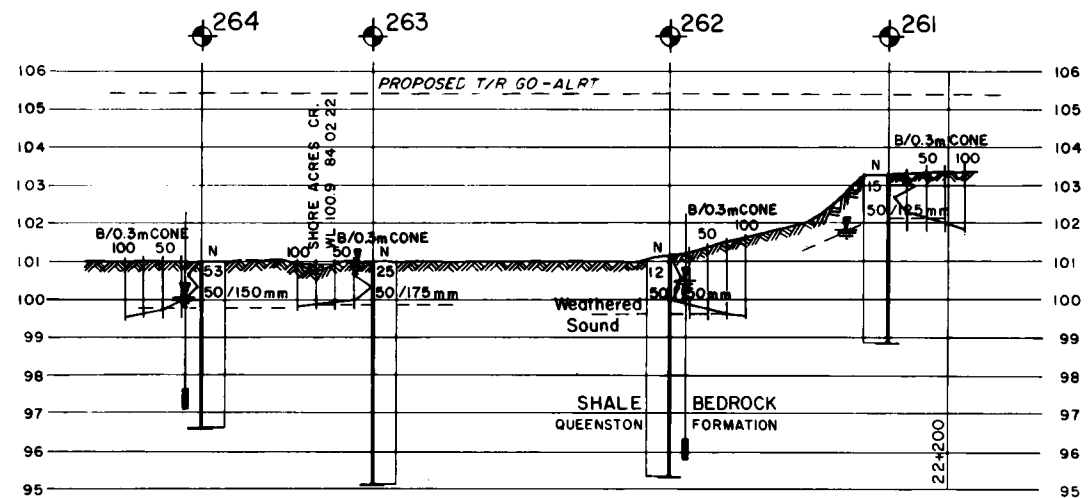
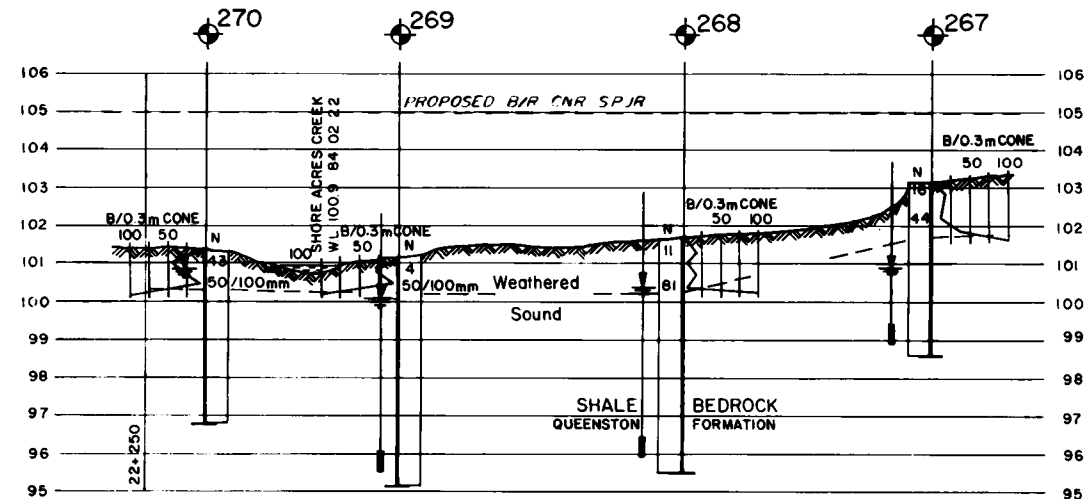
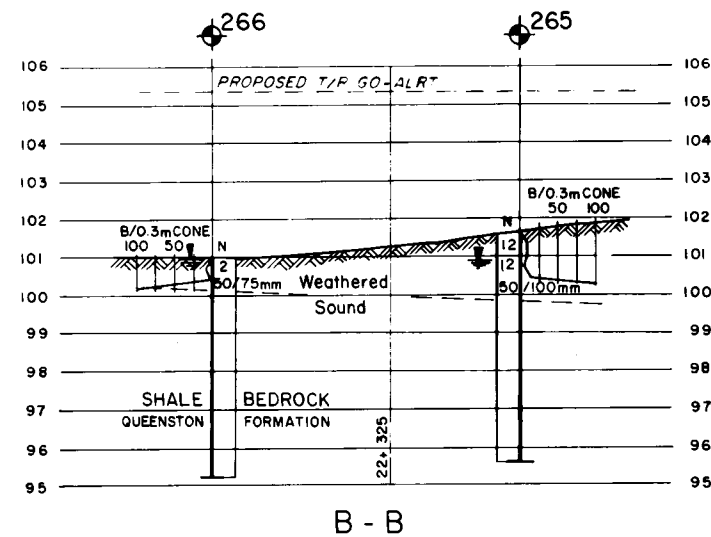
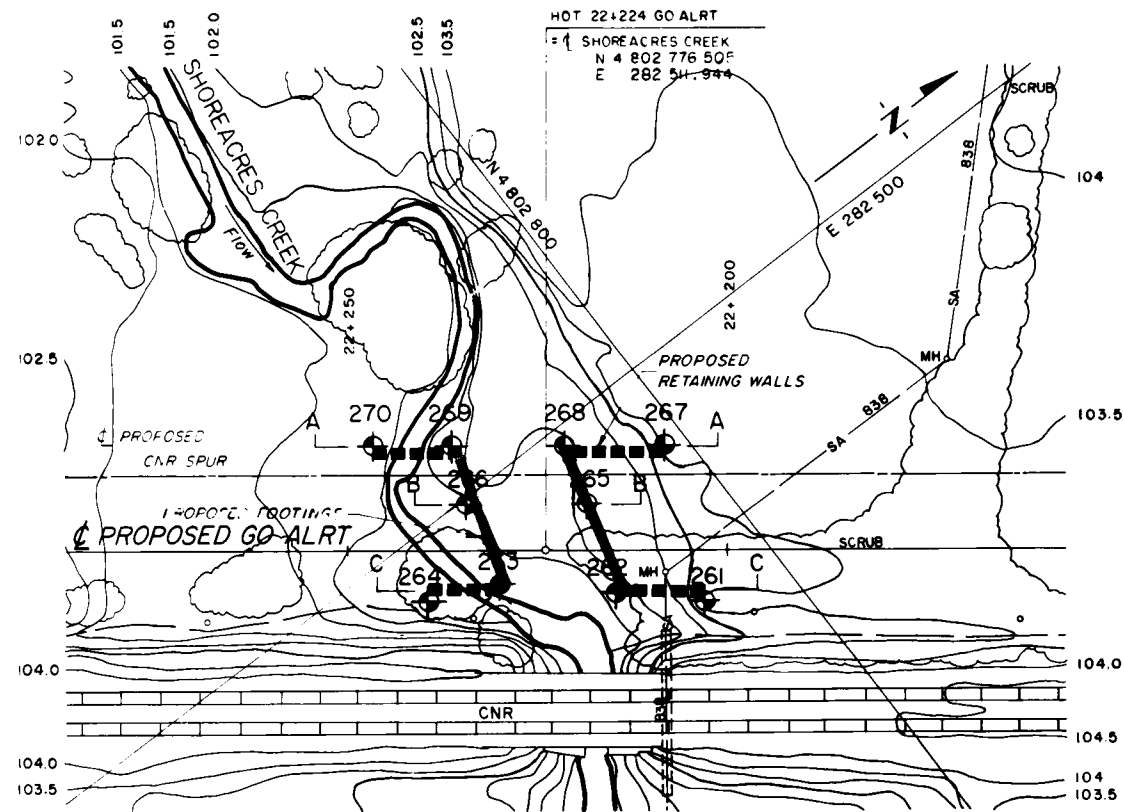
METRIC

W O 82-26025 LOCATION Co-ords N 4 802 767.0 E 282 487.0 ORIGINATED BY GN
DIST 4 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY AP
DATUM Geodetic DATE 84 02 07 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
101.32	Ground Surface		1	SS	43		101						
0.00			2	SS	50/	100mm	100						
	weathered sound		3	RC BXL	94% 0%		99						
	Bedrock Shale Queenston Formation		4	RC BXL	97% RQD 40%		98						
			5	RC BXL	100% RQD 13%		97						
96.85			6	RC BXL	100% RQD 70%		96						
4.47	End of Borehole												
	* frozen severely weathered to ± 400 mm												

METRIC

ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W/L at time of investigation 840222
- ⊥ Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
261	103.24	4 802 789.0	282 530.0
262	101.14	4 802 780.5	282 522.0
263	100.94	4 802 769.0	282 512.0
264	100.98	4 802 760.0	282 508.0
265	101.65	4 802 784.5	282 510.5
266	100.99	4 802 771.5	282 501.0
267	103.10	4 802 797.0	282 510.5
268	101.66	4 802 786.5	282 502.5
269	101.13	4 802 775.0	282 493.5
270	101.32	4 802 767.0	282 487.0


Geocres No

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office. Downview information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102.2 of Form 100.

GO-ALRT REF

REFERENCE DRAWINGS	REVISIONS	DRAWN BY: BS	DESIGNED BY: AP	L.J.RAK ENGINEERING LTD.	 <p>GO-ALRT Ministry of Transportation and Communications OAKVILLE PROJECT - WEST EXTENSION</p>	HALTON REGION			
		1984 02 23	AP			SHOREACRES CREEK BRIDGES			
		CHK'D BY: AP	AP			BOREHOLE LOCATIONS & SOIL STRATA			
		SCALE: FULL SIZE ONLY AS SHOWN				STA 22 + 224.000 GO-ALRT			
						CONTRACT NO	DWG NO	REV	SHEET